

Formulations of Ramipril

FIELD OF THE INVENTION

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The present invention relates to stable pharmaceutical formulations of ramipril, optionally in combination with a diuretic.

TECHNICAL BACKGROUND AND PRIOR ART

10 Ramipril, (2S,3aS,6aS)-1[(S)-N-[(S)-1-carboxy-3-phenylpropyl] alanyl] octahydrocyclopenta[b]pyrrole-2-carboxylic acid, 1-ethyl ester is an angiotensin converting enzyme (ACE) inhibitor. Ramipril is used for the treatment of hypertension, heart failure, stroke, myocardial infarction, diabetes and cardiovascular disease.

15 Ramipril and the acid form, ramiprilat, is described in EP 0 097 022 B1.

The preparation of stable pharmaceutical formulations of ramipril is complicated since it is susceptible to certain types of degradation. Ramipril can undergo cyclization via internal nucleophilic attack to form substituted
20 diketopiperazines and also degrade via hydrolysis and oxidation.

EP 1 501 546 A1 describes stable pharmaceutical formulation for combinations of a statin and an ACE inhibitor. The problem underlying the invention is that if an ACE inhibitor is in the presence of a stabilised statin, the
25 ACE inhibitor decomposes to such extent that even after short storage period the content of decomposition products exceeds the permissible limit of degradation. EP 1 501 546 A1 provides a formulation wherein the statin and the ACE inhibitor are separated by physiologically acceptable inert material. Calcium sulfate is mentioned as a possible inorganic filler in the formulation
30 but it is neither claimed nor mentioned in any example. In fact all the examples are concerned with three-layer tablet, wherein the statin layer and

ACE inhibitor layer are separated by a layer of microcrystalline cellulose. Combinations of the ACE inhibitor with a diuretic are not mentioned.

5 US 2003/0215526 claims formulations of ACE inhibitor a pharmaceutical composition comprising a therapeutically effective amount of an ACE inhibitor which is susceptible to degradation or its salt; a greater than stoichiometric amount of an alkali or alkaline earth metal carbonate, relative to the amount of ACE inhibitor or its salt, and a pharmaceutically acceptable carrier. The excipient calcium sulphate is not mentioned.

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EP 0 280 999 B1 describes a composition comprising ACE inhibitor (i.e. ramipril), an alkali or alkaline earth metal carbonate and saccharide wherein the ACE inhibitor is stabilized against degradation (cyclization, discoloration and hydrolysis) by means of the other mentioned ingredients. In the
15 specifications the relevant saccharides are lactose and mannitol. Modified starch is mentioned as disintegrant in the specification.

EP 0 317 878 B1 claims a stable, compressed pharmaceutical formulation containing a compound of a defined formula (i.e. ramipril) wherein, for
20 stabilization before compression, a compound of the formula is a) coated with a polymeric, physiologically tolerated protective coating, or b) mixed with a physiologically tolerated buffer which ensures that a pH in the weakly acidic to weakly alkaline range is set up in a pharmaceutical formulation in the presence of moisture, where sodium bicarbonate is excepted as buffer, or c)
25 mixed with a physiologically tolerated buffer which ensures that a pH in the weakly acid to weakly alkaline range is set up in a pharmaceutical formulation in the presence of moisture, and is coated with a polymeric, physiologically tolerated protective coating, where, in the case of stabilization according to b) with alkali metal or alkaline earth metal carbonate, the formulation is free of
30 sugar.

WO 93/17685 claims combinations of ACE inhibitors and diuretics such as hydrochlorothiazide. Sodium hydrogen carbonate, pregelatinised starch and magnesium stearate are mentioned as excipients. Calcium sulphate is not
35 mentioned.

Compositons of ramipril and piretanide is described in EP 215 357 B1.
Calcium sulfate is not mentioned in this patent.

WO 03/028707 claims a formulation containing ramipril and lactose
5 monohydrate. Calcium sulfate is mentioned in the specification as a possible
diluent. Calcium sufate is not included in any example.

SUMMARY OF THE INVENTION

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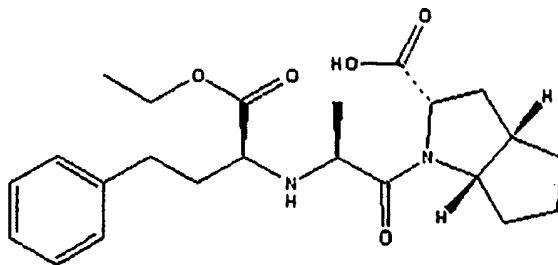
In an attempt to prepare a stable tablet formulation of ramipril, it was
discovered that useful formulations can be produced by the use of calcium
sulphate dihydrate (e.g. Compactrol) as filler material.

15 Properties of calcium sulphate are described in A. H. Kibbe, Handbook of
pharmaceutical excipients, 73 – 76, American Pharmaceutical Association,
Washington, and Pharmaceutical Press, London, 2000.

Calcium sulphate dihydrate is known as an inert diluent in compressed
20 tablets. However, it was surprising that the stability of the tablets proved to be
very satisfying.

DETAILED DESCRIPTION

25 The invention provides a pharmaceutical formulation comprising ramipril,



Compactrol as filling agent, and sodium hydrogen carbonate as stabilation agent.

The pharmaceutical formulation of the present invention comprises typically:

- 5 a) 0.1 – 5.0% w/w of ramipril;
b) 50 - 95% w/w of Compactrol;
c) 0.1 – 5.0% w/w of sodium hydrogen carbonate;
and optionally disintegrant (e.g. starch), binder and/or lubricant (e.g. sodium stearyl fumarate).

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The formulation optionally also includes a diuretic, such as hydrochlorothiazide or piretanide.

- 15 For the tablet formulation containing 1.25 mg ramipril, the preferred amount of ramipril is 0.5-1.5% w/w, the amount of Compactrol is 85-90% w/w, the amount of sodium hydrogen carbonate is 0.5-1.5% w/w, the amount of starch pregelatinised is 7-13% w/w and the amount of sodium stearyl fumarate is 0.5-1.5% w/w.

- 20 For the tablet formulation containing 2.5 mg, 5 mg and 10 mg ramipril, the preferred amount of ramipril is 1.4-2.5% w/w, the amount of Compactrol is 78-95% w/w, the amount of sodium hydrogen carbonate is 1.4-2.5% w/w, the amount of starch pregelatinised is 7-13% w/w and the amount of sodium stearyl fumarate is 0.5-1.5% w/w.

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- For the tablet formulation containing 2.5 mg ramipril/2.5 mg hydrochlorothiazide and 5 mg ramipril/25 mg hydrochlorothiazide, preferred amount of ramipril is 1.4-2.5% w/w, the amount of hydrochlorothiazide is 8.5-10.5% w/w, the amount of Compactrol is 65-75% w/w, the amount of sodium
30 hydrogen carbonate is 1.0-2.5% w/w, the amount of starch pregelatinised is 12-18% w/w and the amount of sodium stearyl fumarate is 0.5-1.5% w/w.

For the tablet formulation containing 5 mg ramipril and 6 mg piretanide, the preferred amount of ramipril is 1.5 – 2.5% w/w, the amount of piretanide is 1.8

– 3.0% w/w, the amount of Compactrol is 65-85% w/w, the amount of sodium hydrogen carbonate is 3.0-5.0% w/w, the amount of starch pregelatinised is 10-20% w/w and the amount of sodium stearyl fumarate is 0.5-1.5% w/w.

- 5 Since ramipril is susceptible to certain types of degradation, there are several impurities formed during the manufacturing process and storing of the tablet. It is of high importance to minimize this degradation. The strength of different exipients was adjusted until a useful formulation was found.
- 10 There are certain criterias that these compounds are not allowed to exceed. The present formulation has proved to be stable.

Ramipril diketopiperazine is one of the compounds formed via degradation. The present formulation proved to be especially stable with regard to
15 formation of the diketopiperazine.

EXAMPLES

The following example is merely illustrative of the present invention and it
20 should not be considered as limiting the scope of the invention.

Example 1

Formulation for 1.25 mg ramipril tablets

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Ramipril	0.96%
Compactrol	87.08 % w/w
Sodium hydrogen carbonate	0.96% w/w
Starch pregelatinised	10.00% w/w
30 Sodium stearyl fumarate	1.00% w/w

Example 2

Formulation for 2.5 mg, 5 mg and 10 mg ramipril tablets

5	Ramipril	1.9% w/w
	Compactrol	85.2 % w/w
	Sodium hydrogen carbonate	1.9% w/w
	Starch pregelatinised	10.0% w/w
	Sodium stearyl fumarate	1.0% w/w

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Example 3

Formulation for 2.5/12.5 mg and 5/25 mg ramipril hydrochlorothiazide (HCT) tablets

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	Ramipril	1.9% w/w
	Hydrochlorothiazide	9.6% w/w
	Compactrol	70.5 % w/w
	Sodium hydrogen carbonate	1.9% w/w
20	Starch pregelatinised	15.0% w/w
	Sodium stearyl fumarate	1.0% w/w

Example 4

25 Formulation for 5/6 mg ramipril piretanide tablets

	Ramipril	1.9% w/w
	Piretanide	2.3% w/w
	Compactrol	76 % w/w
30	Sodium hydrogen carbonate	3.7% w/w
	Starch pregelatinised	15% w/w
	Sodium stearyl fumarate	1% w/w

Example 5

Stability of 5 mg and 10 mg tablets prepared in Example 2 and of marketed preparation were tested at 40°C and 75% relative humidity (RH) for six months. Conversion of ramipril into ramipril diketopiperazine was assayed and measured as relative amount of initial amount of ramipril.

5 mg

	Assay	Ramipril diketopiperazine
10 Tablets from Ex. 2	4.0%	0.478-1.06%
Marketed prepn**.	4.0%	2.77%

10 mg

	Assay	Ramipril diketopiperazine
15 Tablets from Ex. 2	4.0%	0.471-0.806%
Marketed prepn**.	4.0%	2.27%

**RamitabTM ramipril 5 and 10 mg tablets

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The example demonstrates a very good stability with regard to ramipril diketopiperazine formation.